MYCOTAXON

Volume 111, pp. 387–401 *January–March 2010*

Four *Parmeliaceae* species excluded from *Bulbothrix*

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Abstract — Four species previously included in the genus *Bulbothrix* are shown not to form bulbate cilia and are combined into alternative genera as *Hypotrachyna tuskiformis*, *Parmelinopsis pinguiacida*, *P. subinflata*, and *Parmotrema yunnanum*. All species are described in detail and a lectotype is selected for *Bulbothrix tuskiformis*.

Key words — *Bulbothrix pinguiacida*, *Bulbothrix subinflata*, *Bulbothrix yunnana*

Introduction

The genus *Bulbothrix* Hale was proposed for a group of species previously included in *Parmelia* ser. *Bicornutae* (Lynge) Hale & Kurokawa (Hale 1974) characterized by small laciniate, adnate thalli, bulbate marginal cilia, cortical atranorin, simple to branched cilia and rhizines, smooth to coronate apothecia, unicellular, colorless, ellipsoid to bicornute ascospores 5–21 × 4–12 µm, and small, bacilliform to bifusiform conidia 5–10 µm long (Hale 1976b, Elix 1993a).

During a taxonomic revision of the genus we found four species previously included in *Bulbothrix* that do not have the typical cilia with hollow basal bulbae that contain differentiated cells and an oily substance (Hale 1975, Feuerer & Marth 1997) should be classified outside this genus.

These four species are distributed in Southeast Asia and Oceania. *Hypotrachyna tuskiformis* is still only known from the type locality in Papua New Guinea (Elix 1997b), *Parmelinopsis pinguiacida* from New Caledonia and Rarotonga (Louwhoff & Elix 2000a, 2000b), *Parmelinopsis subinflata* from the Philippines, Australia, Malaysia, and Papua New Guinea (Hale 1965, 1976b, Sipman 1993, Streimann 1986), and *Parmotrema yunnanum* from southern China (Wang et al. 2000).

Material and methods

The morphological characteristics were examined under a stereomicroscope, with special attention given to the cilia and rhizines. Anatomical sections of the thalli and

apothecia were made by hand, using steel razor blades. The secondary compounds in the medulla are taken from the literature (Hale 1965, Sipman 1993, Louwhoff & Elix 2000a), having been identified by high performance liquid chromatography (HPLC). The species are described following a detailed standardized protocol adopted by the Lichenological Study Group of the Instituto de Botânica in an effort to generate uniform descriptions for all *Parmeliaceae* species.

For the definition of the bulbae of true bulbate cilia we follow the descriptions in Hale (1975) and Feuerer & Marth (1997). They are globular or oval, hollow structures, with an inflated aspect and paraplectenchymatous carbonized walls formed by agglutinated hyphae, which contain oil-forming cells (idioblasts) and a colorless oily substance (yellowish or reddish in older thalli or herbarium specimens). These bulbae usually appear on cilia at the thallus margins, amphithecia, isidia, and sometimes on the upper cortex and the base of rhizines.

According to our interpretation, in *Parmeliaceae*, cilia are basically marginal structures while rhizines grow laminal. Submarginal structures anatomically similar to cilia are interpreted as rhizines if there is a morphological continuity from the border to the center of the thallus that normally presents only a range in size due the structure ageing. A submarginal structure that is evidently longer than the young ones surrounding it or is growing from a nude marginal zone is considered a cilium.

The method used to confirm the anatomical structure of cilia consists of removing a portion of the thalline margin, gently dissecting it [razor blade], and placing it on a glass slide containing a drop of commercial bleach (sodium hypochlorite) solution.

The solution gradually clarifies the sample without damaging the structure of the hyphae, dissolving the dark pigment of the cilia and rhizines and making it easy to visualize the hyphae, and in the case of true basal bulbae, the internal cavity, the idioblasts, and the oily substances present.

Following this procedure, the structures are gently compressed (which can also be done without the C clarification), in order to verify the presence of the idioblasts and oily substances under the optical microscope.

Hypotrachyna tuskiformis (Elix) Benatti & Marcelli, **comb. nov.** Fig. 1

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≡ *Bulbothrix tuskiformis* Elix, Mycotaxon 65: 482. 1997.

Lectotype (**here designated**)—Papua New Guinea, Southern Highlands, Andawe River, Lama Sawmill logging area, 6 km SE of Ialibu, 6°20'S, 144°01'E, 1840 m, on *Nothofagus* crown in *Nothofagus-Podocarpus* forest, J.A. Elix & H. Streimann 12680A, 11-XII-1982 (CANB!).

Thallus laciniate, sublinear, becoming pale dusky gray in the herbarium, fragments up to 3.0 cm diam., subcoriaceous, corticolous, upper cortex 7.5–12.5 µm thick, algal layer 15.0–20.0 µm thick, medulla 57.5–80.0 µm thick, lower cortex 7.5–12.5 µm thick. Laciniae dichotomous or trichotomous branched or occasionally irregularly ramified, 0.3–0.8 (–1.2) mm wide, contiguous to weakly imbricate in the center, adnate and adpressed, with flat, truncate apices, the

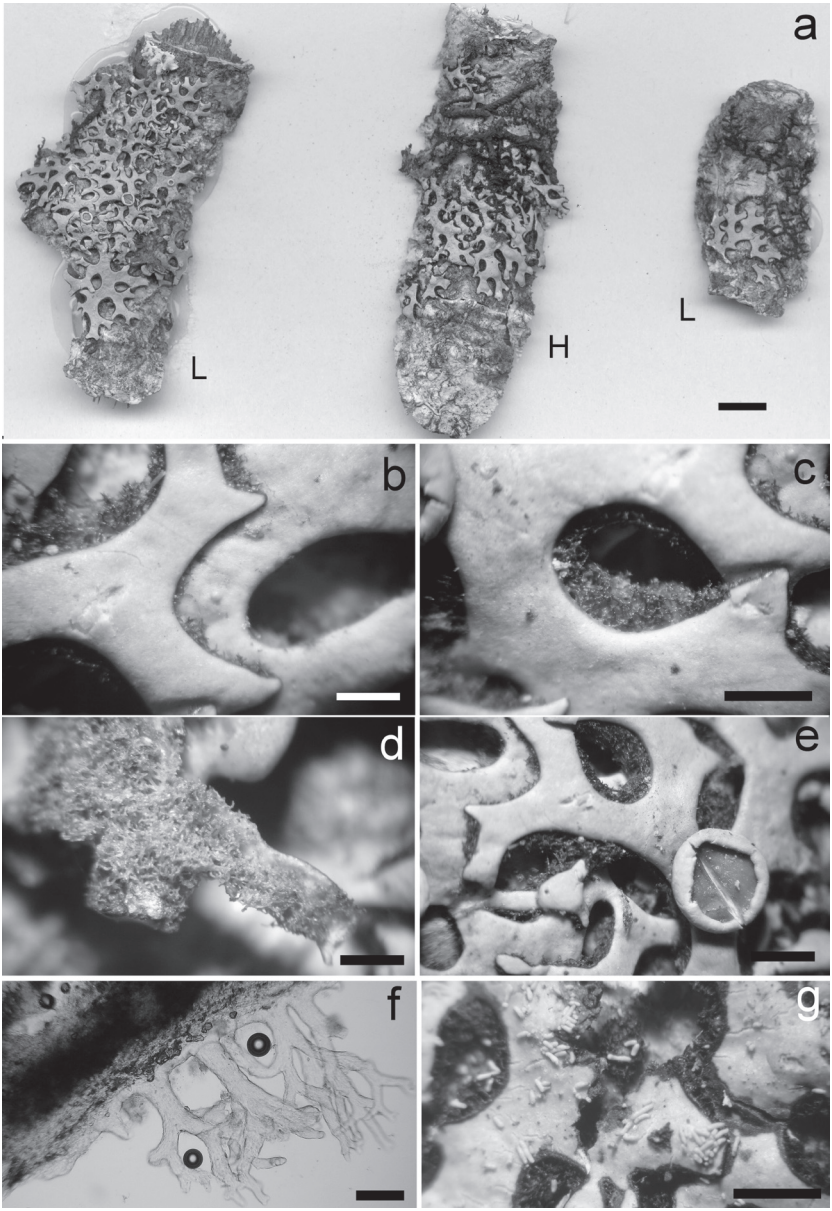

Figure 1. Type material of *Hypotrachyna tuskiformis* (CANB).
a - the lectotype (L) with the *Hypotrachyna* specimen in between (H); b–c - detail of cilia; d - tomentum; e-apothecium; f - rhizines; g - isidia of the inmixed *Hypotrachyna* specimen. Bars: a = 5mm; b–e and g = 1 mm; f = 0.2 mm

margins flat, smooth, entire, the axils oval or irregularly shaped, upper cortex continuous and smooth with transversal cracks on older parts. Maculae absent. Cilia absent, however the rhizines often grow close to the edge of the lower marginal zone and project beyond it, eventually turning to the side or upwards. Lacinulae scarce, marginal and adventitious, short, flat, simple, truncate or sometimes acute, underside concolorous with the lower marginal zone, 0.2–1.0 × 0.1–0.2 mm wide. Soredia, Pustulae and Isidia absent. Medulla white. Lower surface pale brown, shiny, smooth, densely rhizinate. Marginal zone pale brown, not distinct from the center, shiny, smooth, generally rhizinate to the margin. Rhizinae pale brown, concolorous with the lower cortex or darker, initially furcate in the marginal zone but becoming densely dichotomous or irregularly branched toward the center, not bulbate at the base and lacking dark swellings, 0.10–0.40 × ca. 0.02 mm, with abundant tomentose rhizoids projecting to 1 cm beyond the edges, evenly distributed. Apothecia subplane to concave, adnate to substipitate, 0.4–1.2 mm diam., laminal, margin smooth eventually fissured when old, amphithecium smooth, rugose on the junction with the stipe, not ornamented. Disc pale brown, epruinose, imperforate, epithecium 10.0–12.5 µm high, hymenium 62.5–75.0 µm high, subhymenium 20.0–25.0 µm high. Ascospores reniform to allantoid, 9.0–12.0 × 2.0–4.0 µm, epispore ca. 0.75 µm thick. Pycnidia sparse, laminal, ostiole black. Conidia bacilliform to short filiform, 5.0–7.5 (–9.5) × 0.75 µm.

Spot tests: cortex K+ yellow, UV–; medulla K+ yellow → dark red, C–, KC–, P+ yellow, UV–.

TLC/HPLC: cortical atranorin; medullary salazinic acid and consalazinic acid (Elix 1997b).

Distribution—Oceania: Papua New Guinea (Elix 1997b).

Comments—*Hypotrachyna tuskiformis* is characterized by the sublinear dichotomously branched laciniae, a smooth, continuous, emaculate upper cortex, smooth and sinuous, eciliate margins, the absence of vegetative propagules, a pale brown lower cortex covered with dense brown dichotomously branched rhizines, a smooth unornamented apothecial margin, reniform to allantoid ascospores, bacilliform or short filiform conidia, and the presence of cortical atranorin and medullary salazinic acid.

This species is here tentatively placed in *Hypotrachyna* because of the absence of marginal cilia and presence of dense dichotomous rhizines and the aspect of the laciniae.

The holotype consists of three fragments on pieces of bark glued to the voucher. Two fragments (marked as "A" in the sample and "L" in Fig. 1) belong to the same species, and meet most of the features mentioned in the original description (Elix 1997b), except for the absence of marginal cilia. The larger

fragment is fertile, while the other is small, ca. 1 cm wide. These fragments were selected as the lectotype of *H. tuskiformis*.

The fragment in between, ca. 2 cm wide, belongs to another species of *Hypotrachyna* (Fig. 1a, marked H). This species has a black lower cortex and rhizines, is densely maculate and isidiate (Fig. 1g). The black margin is more obvious in this specimen than in the other two fragments, due to the dark lower cortex. Spot tests indicate that this fragment also contains medullary salazinic acid. We have not studied it further as it is unrelated to *Bulbothrix*.

Another characteristic that differs from the original description relates to the ascospores, which were described as being semi-lunate like those of *B. semilunata* (Lynge) Hale (S!) or *B. bicornuta* (Müll. Arg.) Hale (BM! and G!). In fact they are allantoid or reniform.

Bicornute (semi-lunate) ascospores are crescent-shaped with acute apices, while those of *H. tuskiformis* have short, rounded apices, and are narrow bean- or kidney-shaped. In bicornute ascospores the lumen is restricted to the central portion of the spore, while in the allantoid or reniform ascospores, the lumen is uniformly distributed throughout.

According to Elix (1997b), *B. tuskiformis* resembles *B. suffixa* (Stirt.) Hale (BM! holotype, GLAM! isotype), which has laciniae with closer internodes, more sinuous and irregular margins, and bulbate cilia.

Parmelinopsis pinguiacida (Louwhoff & Elix) Marcelli & Benatti, **comb. nov.**

MycoBank MB 515686 Fig. 2 a–d

≡ *Bulbothrix pinguiacida* Louwhoff & Elix, Mycotaxon 75: 195. 2000.

Holotype—New Caledonia, Grande Terre, Ciu Cascades, near Canala, 21°37'S, 165°38'E, 400 m, on exposed rocks, S.H.J.J. Louwhoff & J.M. Porigneaux 754, 29-VI-1999 (PC, isotype in CANB!).

Thallus sublaciniate, subirregular, pale dusky gray in the herbarium, fragment up to 3.0 cm diam., submembranaceous, saxicolous, upper cortex 10.0–15.0 µm thick, algal layer 15.0–25.0 µm thick, medulla 25.0–37.5 µm thick, lower cortex 12.5–17.5 µm thick. Laciniae irregularly to subdichotomously branched, 0.9–2.6 mm wide, subimbricate, weakly to loosely adnate, with flat, subrotund to truncate apices, the margins slightly undulate, crenate to sinuous, entire to incised, sometimes sublacinulate, with a distinct, thick and massive marginal black line thickening mainly in the axils, the axils oval to irregular, upper surface continuous and smooth, occasionally with a few irregular cracks. Maculae absent. Cilia black, simple, with long, rarely furcate, ascending apices, 0.05–1.00 × ca. 0.05 mm, the base frequently enlarged but not bulbate, originating in part from massive, thickened portions (0.05–0.45 mm thick) of the black, marginal line, frequent throughout or mainly restricted to the axils. Lacinulae common in the older parts, marginal, adventitious, short, flat,

simple to furcate or irregularly branched, subrotund to truncate, underside concolorous with the lower marginal zone, 0.05–0.80 × 0.05–0.50 mm. Soredia (see comments) and Isidia absent. Pustuloid structures appearing from the margins or sometimes on the apices of adventitious lacinulae, rugose and somewhat distorted, hollow in part, the walls occasionally breaking down to form coarse granules, resembling corticate, granular soredia. Medulla white. Lower surface black, shiny, smooth, sometimes slightly veined, sparsely rhizinate. Marginal zone attenuate, brown, shiny, 0.5–1.5 mm wide, smooth to subrugose or veined, usually naked. Rhizinae black, simple, acute, without bulbate bases or dark swellings, 0.10–0.70 × ca. 0.05 mm, sparse, sometimes agglutinated. Apothecia and Pycnidia not seen.

Spot tests: cortex K+ yellow, UV–; medulla K–, C–, KC–, P–, UV–.

TLC/HPLC: cortical atranorin and chloroatranorin; medullary unknown fatty acids and traces of lecanoric acid (possibly a contaminant) (Louwhoff & Elix 2000a).

Distribution—Oceania: New Caledonia (Louwhoff & Elix 2000a) and Rarotonga (Louwhoff & Elix 2000b).

Comments—*Parmelinopsis pinguiacida* is characterized by the smooth and continuous, emaculate upper cortex, subirregular laciniae with sinuous, crenate margins, cilia often with enlarged bases, the formation of marginal pustules which form corticate granules, a black lower cortex with black, simple, sparse rhizinae, and by the presence of medullary fatty acids.

The holotype has not yet been located in PC. The isotype in CANB consists of a fragment (half of the original thallus) on a small piece of rock. The material is consistent with the photograph in Louwhoff & Elix (2000a) and the description given by the authors, who correctly reported the base of the cilia as being "enlarged, but not conspicuously bulbate".

We found no genuine bulbate cilia or rhizines. Although several cilia had a wide base, they are neither globose nor oval, do not have an internal cavity, and contain neither the typical cells (idioblasts) nor the oily substance present in true bulbae as seen in species of *Bulbothrix* or *Relicina* (Hale 1975, 1976b, Feuerer & Marth 1997).

Cilia with broad bases are often observed in *Parmelinopsis*, e.g., in *P. minarum* (Vain.) Elix & Hale and *P. horrescens* (Taylor) Elix & Hale, and less distinctly in *P. damaziana* (Zahlbr.) Elix & Hale, *P. spumosa* (Asahina) Elix & Hale and *P. subinflata* (see ahead). These are not really bulbate but inflated, although not always as distinct as those seen in the type material of *P. pinguiacida* (and of *P. subinflata*, see below).

In the axils of the laciniae and crenae, the thickening of the black marginal line somewhat resembles that seen in the type of *Parmotrema yunnanum*

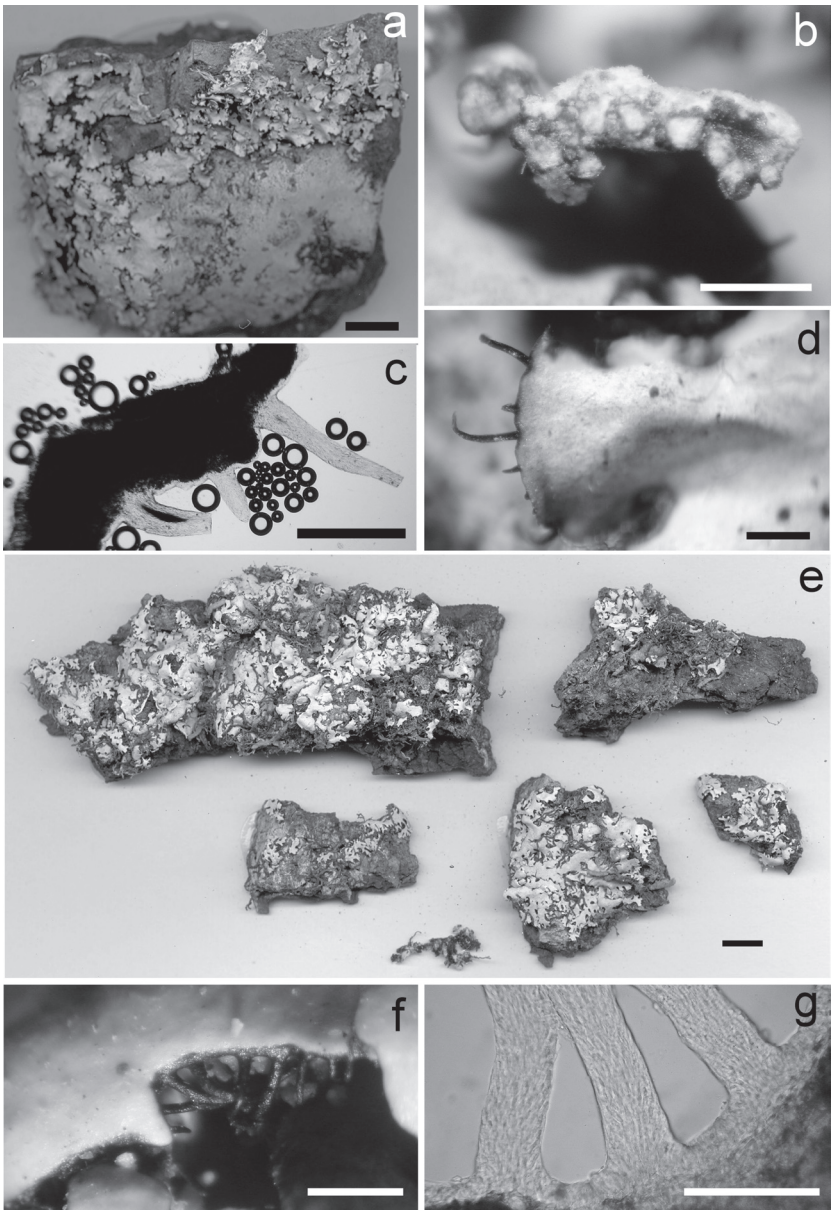

Figure 2. a–d - isotype of *Parmelinopsis pinguiacida* (CANB).
a - thallus; b - pustuloid structure; c–d - details of the cilia.
e–g - holotype of *Parmelinopsis subinflata* (US): e - thallus; f–g - details of the cilia.
Bars: a - 5 mm; b–f = 0.5 mm; g = 0.1 mm.

(see below). The thickened margin of both species is not hollow, there are no idioblasts, and no oily substance. There is no evidence that this thickening occurs from an enlarged and very extended bulba, as occurs for example in *B. tabacina* (Mont. & Bosch) Hale or *B. ventricosa* (Hale & Kurok.) Hale, or by somewhat laterally fused bulbae of any kind.

We are unsure about what the authors referred to as the presence of pustules (Louwhoff & Elix 2000a). Pustules are not distinct on the isotype, and we are not sure that the observable deformations of the thallus surface really represent such structures. These "pustuloid" structures are mainly marginal and not fully hollow, forming corticated granular soredia, where the walls disintegrate in part, into coarse granules.

Louwhoff & Elix (2000a) compared *B. pinguiacida* to *B. lopezii* Hale, which has apically branched cilia, true basal bulbae containing the characteristic idioblasts and oily substances, and form dense dichotomous laminal lacinulae, but lacks vegetative propagules.

Parmelinopsis spumosa and *P. subfatiscens* (Kurok.) Elix & Hale form laminal pustules, rather than marginal 'pustuloid structures', and have different medullary chemistries that react with spot tests (Hale 1976a).

Parmelinopsis subinflata (Hale) Benatti & Marcelli, **comb. nov.** Fig. 2 e–g

MycoBank MB 515687

≡ *Parmelia subinflata* Hale, Journal of Japanese Botany 40: 201. 1965.

Holotype—Philippines, Negros Occidental, near Mt. Mandalagan, ILCO logging area in virgin dipterocarp forest about 50 miles south of Fabrica, alt, 850 m, M. E. Hale & J. Banaag 26641, VII-1964 (US!; isotypes in TNS! and UPS!).

≡ *Bulbothrix subinflata* (Hale) Hale, Phytologia 28(5): 481. 1974.

= *Parmelinopsis protocetrarica* Elix, Mycotaxon 47: 119. 1993 (CANB!, holotype).

Thallus sublaciniate, sublinear, pale dusky in the herbarium, fragments up to 4.0 cm wide, submembranaceous, corticolous, upper cortex 12.5–15.0 µm thick, algal layer 12.5–17.5 µm thick, medulla 75.0–90.0 µm thick, lower cortex 10.0–17.5 µm thick. Lobes irregularly to dichotomously branched, 0.3–1.1 (–1.7) mm wide, contiguous or becoming slightly imbricate to the center, adnate and adpressed, with flat to involute, subtruncate to truncate or sometimes acute apices, the margins flat to slightly involute, subcrenate to sinuous or somewhat subirregular, entire to partly incised, frequently sublacinulate, the axils oval, upper surface smooth and continuous, ±subrugose on older parts. Maculae absent. Cilia black, with simple, rarely irregularly ramified and commonly descending apices, 0.05–0.25 (–0.50) × ca. 0.05 mm, base occasionally enlarged but not bulbate, frequent along the margin or becoming more abundant in some parts, usually absent or sparse on the apices of the laciniae. Lacinulae

common, marginal and adventitious, short, flat, simple to irregularly branched, truncate to acute, underside concolorous with the lower marginal zone, 0.1–0.6 × 0.1–0.2 mm. Soredia and pustulae absent. Isidia granular to smooth and short cylindrical or sublageniform, 0.05–0.35 (–0.70) × 0.05–0.10 mm, simple to sparsely branched, erect, straight to curved, usually caducous, concolorous with the cortex, eciliate, appearing in small sparse groups, laminal or occasionally marginal. Medulla white. Lower surface pale brown to ivory white on some erhizinate parts, shiny, smooth, papillate to moderately or densely rhizinate. Marginal zone indistinct from the center, pale brown to ivory white, shiny, smooth, papillate or rhizinate. Rhizinae black, initially simple and acute but soon becoming subdichotomous, squarrose or irregularly branched, with occasionally slightly enlarged but non-bulbate bases, 0.10–0.80 × ca. 0.05 mm, frequent to abundant and causing a somewhat tomentose aspect on some parts, ±evenly distributed to partially grouped. Apothecia subconcave, adnate, 0.3–0.8 mm diam., laminal, margins crenate and rugose, amphithecium smooth, occasionally isidiate. Disc pale brown, epruinose, imperforate, epithecium 7.5–10.0 µm high, hymenium and subhymenium (poorly developed and hard to distinguish) 37.5–52.5 µm high. Ascospores not seen (hymenium without asci). Pycnidia sparse, laminal, with black ostioles. Conidia bacilliform, 3.0–6.0 × 0.75 µm.

Spot tests: cortex K+ yellow, UV–; medulla K–, C–, KC+ rose, P+ orange, UV–.

TLC/HPLC: cortical atranorin; medullary protocetraric acid (Hale 1965, 1976b).

Distribution—Oceania: Papua New Guinea (Streimann 1986). Asia: Philippines (Hale 1965, 1976b), Malaysia (Hale 1965, 1976b, Sipman 1993). Australia (Elix 1993b).

Comments—*Parmelinopsis subinflata* is characterized by the smooth, emaculate upper cortex, narrow sublinear laciniae, subcrenate to sinuous margins, cilia with partially enlarged bases, simple laminal eciliate isidia, pale brown to ivory white lower cortex, simple to irregularly branched black rhizines, and presence of medullary protocetraric acid.

The type material consists of fragments on pieces of bark, some of them with a few immature apothecia and a few pycnidia. Some fragments are more isidiate than others. The comments of Hale (1965, 1976b) give the impression that the cilia are bulbate, but the inflation of the bases is barely perceptible. Even in the photograph showing the cilia in detail (Hale 1965) one cannot see bulbae clearly.

Contrary to what was described by Hale (1965, 1976b), bulbae appeared totally absent from the cilia and the base of rhizines in the type material.

Occasionally, some of the cilia are slightly expanded at the base due to the development of the marginal black line that thickens in some parts. This is somewhat similar but less prominent than that observed in *P. pinguiacida*.

No cilia in the specimens examined had typical *Bulbothrix*-type bulbae, but they were consistent with those commonly found in *Parmelinopsis*. No evidence for the formation of basal bulbae or the presence of the oily substance commonly found in *Bulbothrix* was observed. Further, the margin has a distinct and salient black line, very common in this genus.

The isidia of *P. subinflata* are simple or rarely weakly branched, eciliate and concolorous to the upper cortex. They are very scarce in the type material, forming small scattered groups, but sometimes they also occur on the margins.

The lower cortex is pale brown, becoming ivory white where the papillae and rhizines are absent. The rhizines tend to form entangled clusters, leaving some parts of the lower surface bare. There is a tendency of these clusters to be formed in the more distal portions of laciniae, whereas the ivory white color is usually restricted to the proximal areas.

Hale (1976b) compared *B. subinflata* to *B. pigmentacea* (Hale) Hale, citing only differences in altitude where the species occur in the same locality. *Bulbothrix pigmentacea* (US! holotype) has apically branched, genuine bulbate cilia and rhizines, lacks medullary acids, and has a K– reddish pigment in spots in the medulla, lower cortex, and rhizines.

Bulbothrix chowoensis (Hale) Hale is a further species that contains medullary protocetraric acid (Hale 1976b), but it lacks isidia. Hale commented that *B. chowoensis* "had no strongly bulbate cilia" in his comments on *B. subinflata*, and did not describe the cilia in his description of *B. chowoensis*. However, the type material of *B. chowoensis* (BM! holotype, US! isotype) is a genuine *Bulbothrix* with sparse cilia, similar to those normally found in *Bulbothrix* species containing medullary norstictic acid.

Parmelinopsis jamesii (Hale) Elix & Hale (Hale 1972) is also similar to *P. subinflata* but contains fumarprotocetraric as the principal medullary acid, with protocetraric acid being a minor accessory. *P. jamesii* also differs in having wider laciniae (1.5–3.0 mm) and a black lower cortex (Hale 1972, 1976a). Although the rhizines of *P. jamesii* were described as being simple, they can become sparsely squarrose branched like those in the type of *P. subinflata*.

Parmelinopsis protocetrarica (CANB! holotype) is being placed in the synonymy of *P. subinflata*. Comparison of the type material of both denotes only that the material of *P. protocetrarica* is more isidiate. The descriptions of *P. protocetrarica* (Elix 1993b, Louwhoff & Elix 2002) mention gyrophoric acid as another (minor) medullary substance, the only apparent difference between

the types. We are not sure if the gyrophoric acid is a common or occasional accessory secondary substance present in this species, or whether it may possibly be a contaminant.

Parmotrema yunnanum (Sheng L. Wang, J.B. Chen & Elix) Marcelli & Benatti, **comb. nov.** Fig. 3

MycoBank MB 515688

≡ *Bulbothrix yunnana* Sheng L. Wang, J.B. Chen & Elix. Mycotaxon 76: 293. 2000.

Holotype—China, Yunnan, Zhongdian County, 3700 m, on bark of *Acer* sp., X.Y. Wang, X. Xiao & J.J. Su 5669, 14-VIII-1981 (HMAS-L!, isotype in CANB!).

Thallus laciniate, subirregular to sublinear, dusky gray in the herbarium, fragments up to 4.2 cm diam., coriaceous, corticolous, upper cortex 15.0–20.0 µm thick, algal layer 15.0–25.0 µm thick, medulla 42.5–60.0 µm thick, lower cortex 17.5–25.0 µm thick. Lobes irregularly dichotomously to partially anisotomic dichotomously ramified, 0.7–3.2 mm wide, contiguous to slightly imbricate or crowded, adnate and adpressed, with flat to involute, subtruncate to truncate apices, the margins flat, subcrenate to crenate or irregular, entire to slightly incised, moderately sublacinulate at some parts, the axils oval or irregular, upper surface smooth and continuous, occasionally irregularly cracked (sometimes the cracks hidden by lacinules). Maculae punctiform, laminal, distinguishable mainly on young parts and in some areas of the center, sometimes aggregating and forming larger effigurate spots. Cilia black, the initially simple and long apices commonly becoming irregularly branched, 0.05–1.35 × 0.03–0.10 mm, base occasionally enlarged but not bulbate, originating from a thick, massive, and irregularly interrupted black marginal line, 0.05–0.55 mm thick, frequent throughout the margin but becoming more prominent in the axils and adjacent areas, absent at the apices of laciniae. Lacinules frequent to abundant, mostly laminal, sometimes also marginal (partially adventitious), usually prostrate on the cortex or one over the other, short, flat to slightly circinate, initially simple and oblong or spathuliform becoming furcate or irregular as they develop, truncate, underside brown, black or concolorous with the lower marginal zone, 0.05–0.40 (–1.00) × 0.05–0.20 (–0.60) mm. Soredia, pustules and Isidia absent. Medulla white. Lower surface black, shiny, smooth to subrugose, densely rhizinate. Marginal zone indistinct from the center to attenuated, black to brown, shiny, 0.5–1.5 mm wide, smooth, slightly papillate, generally rhizinate to the edges. Rhizines black, even at the marginal zone, initially simple or frequently furcate, irregularly or squarrosely branched, without bulbate bases or dark swellings, 0.10–1.25 × 0.03–0.10 (–0.15) mm, abundant, evenly distributed, commonly agglutinated. Apothecia concave to plane, substipitate to sessile, 0.5–3.2 mm diam., laminal, margins smooth

to irregular sometimes turning involute and retorted, eciliate, amphithecium smooth becoming rugose, lacking ornamentation. Disc pale brown to brown, epruinose, imperforate, epithecium 7.5–10.0 µm high, hymenium 45.0–50.0 µm high, subhymenium 30.0–35.0 µm high. Ascospores ellipsoid, the apices sometimes slightly acuminate, with a spindle like aspect, 7.5–12.5 × 4.0–5.0 µm, epispore ca. 0.5 µm. Pycnidia not seen.

Spot tests: cortex K+ yellow, UV–; medulla K–, C–, KC–, P–, UV–.

TLC/HPLC: cortical atranorin; medullary caperatic acid and traces of unknown fatty acids (Wang et al. 2000). According to a label added to the isotype, Elix restudied the chemistry in 2006 by TLC in solvent C, and found secalonic acids A and C, and an unidentified fatty acid (Rf 17).

Distribution—Asia: China (Wang et al. 2000).

Comments—This species is misplaced in *Bulbothrix* and is being very tentatively placed in *Parmotrema* based on the habit of the thallus, and the size and conformation the lobes.

The punctiform and effigurate maculae pattern and the branched and squarrose cilia and rhizines place this species possibly in the group related to *Parmotrema consors* (Nyl.) Krog & Swinscow; taxa in this group have formerly been included in *Canomaculina* [*Rimelia*,] or *Rimeliella*, genera now synonymised with *Parmotrema* (Elix & Hale 1987, Elix 1997a, Blanco et al. 2005).

Parmotrema yunnanum is characterized by subirregular laciniae, a smooth upper cortex, the formation of circinate, eciliate laminal lacinulae, simple to irregularly branched cilia, a thick and massive marginal black line, black lower cortex, simple to irregularly branched or weakly squarrose rhizines, unornamented apothecia, and by the presence of medullary secalonic and fatty acids. The ascospores are small for the genus, usually ellipsoid but sometimes fusiform with a slightly acuminate apex.

The holotype and isotype consist of several fragments in good condition. Although the holotype contains several apothecia, the isotype is sterile. Seen without a stereomicroscope, the thallus appears to have several small procumbent isidia on its surface, due to the circinate aspect of the lacinulae.

Parmotrema yunnanum was described as having "cilia tapered or weakly inflated at the base, ± apically branched" (Wang et al. 2000), suggesting that this species was not a true *Bulbothrix*, but belongs to some other ciliate *Parmeliaceae* where the cilia have an enlarged base instead of being truly bulbate.

Further, the type material lacks idioblasts and the oily substances present in *Bulbothrix* (Hale 1975, Feuerer & Marth 1997). The marginal cilia do not have true bulbae, being only occasionally enlarged and spreading to from a thick and massive marginal black line.

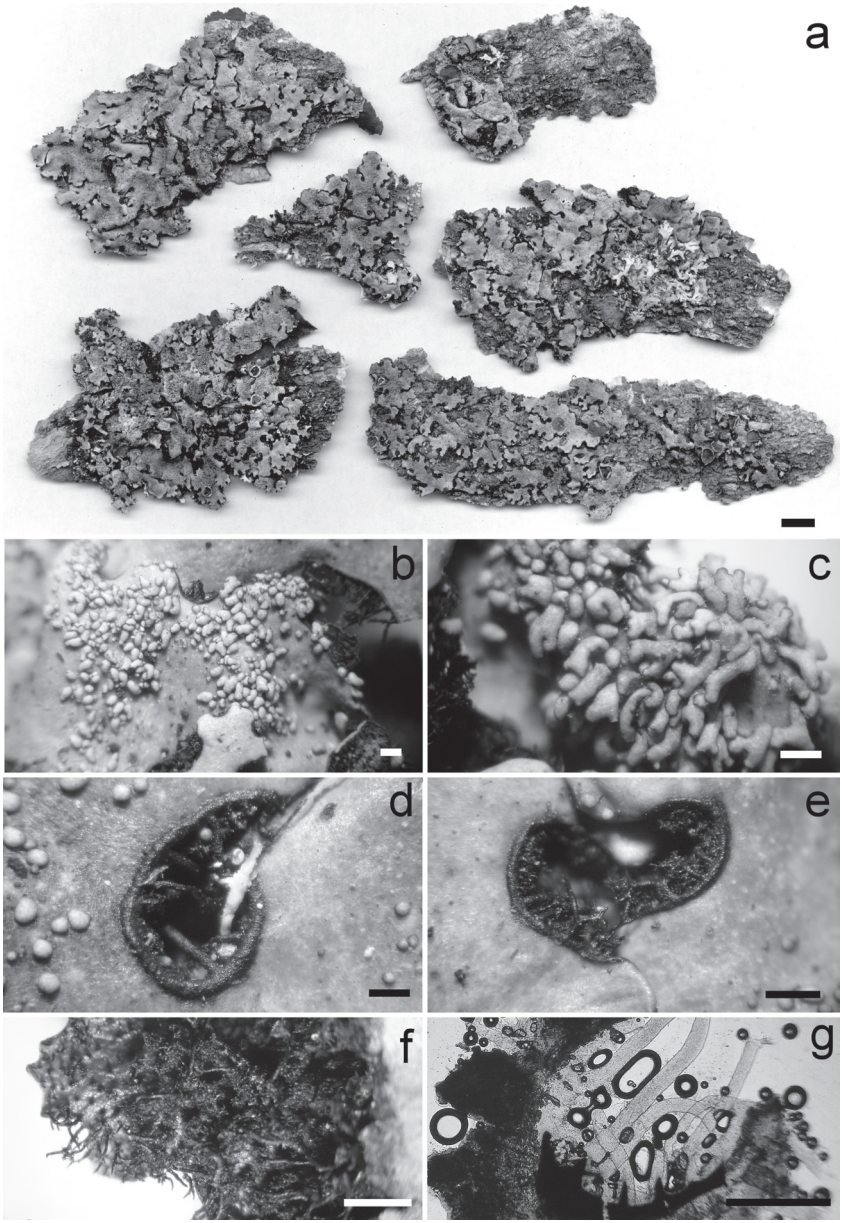

Figure 3. The holotype of *Parmotrema yunnanum* (HMAS).
a - thallus; b–c - detail of lacinules; d - the massive black marginal line;
e - cilia; f - rhizines; g - detail of the cilia.
Bars: a = 5mm; b–g = 0.5 mm

The prominent black margin in this species has a different origin from bulbae, probably due to an excessive growth of the lower cortex, rather than the coalescence of adjacent bulbae, which sometimes leads to the formation of a very thick black margin in some species of *Bulbothrix* (particularly those with mainly axillary cilia).

Bulbothrix suffixa was compared to *B. yunnana* (Wang et al. 2000), since it also forms laminal lacinules. It bears cilia with distinctly inflated bulbae, lacinules with bulbate cilia, and the presence of medullary gyrophoric acid.

Bulbothrix suffixa (BM! holotype, GLAM! isotype) has narrower, dichotomously branched laciniae (0.3–0.9 mm wide), as well as branched cilia and rhizines. However, this species does not produce laminal lacinules (we have seen only some few adventitious, marginal lacinulae) and the type does have what appear to be vestigial, laminal isidia.

Bulbothrix lopezii differs in having prominent bulbate cilia with short, simple apices, short, simple rhizines, flat, dichotomously branched, laminal lacinules, smaller and more rounded ascospores (3.0–6.0 µm long), and an absence of medullary caperatic and secalonic acids (*B. lopezii* only contains traces of fatty acids).

No other *Parmotrema* species, even among those formerly included in *Canomaculina* and *Rimeliella*, shares the characteristics of *P. yunnanum*, in particular, the laminal lacinules, squarrose cilia and rhizines and the lack of positive medullary spot tests.

Acknowledgments

The authors wish to thank John A. Elix (Canberra), Harrie Sipman (Berlin), and Shaun Pennycook (Auckland) for the critical revision of the manuscript, suggestions, English language correction, and discussion; the curators of BM, CANB, G, GLAM, HMAS, and US for loan of type material, and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a research grant to the second author.

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